

Research Article

Invertebrate interceptions at Australia's borders: a nine-year assessment of trends and biosecurity challenges

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Abstract

The introduction of non-native invertebrates poses a significant threat to Australia's environment, biodiversity, agricultural industries, and socio-economic wellbeing, necessitating robust biosecurity measures to prevent their establishment. Global trade and transport are major pathways for these incursions, monitored through national biosecurity interception programs. We analysed nine years of interception records from Australia's national biosecurity invertebrate interceptions dataset (2016–2024), to examine temporal, taxonomic, and pathway trends, providing a novel overview spanning all terrestrial invertebrate taxa. We observed temporal fluctuations in detection frequency, with invertebrates most frequently intercepted between November and February. Interceptions decreased significantly in 2020, following the international border closure as a result of COVID-19, and although the total number of interceptions varied significantly across pre-, during-, and post-COVID periods, species richness remained stable over time. While 2,414 unique species were identified, they represented only 40.5% of intercepted specimens. Furthermore, over the nine years, the diversity of intercepted and identified species showed no signs of plateauing. This underscores the need for ongoing surveillance, efficient taxonomic identification, and standardised data collection across Australia. Analyses of this dataset revealed that interceptions are influenced by commodities of trade and passenger movement, and the trade in live animals, including the smuggling of exotic pet species. We recommend continued enhancements to biosecurity protocols, including more comprehensive interception records and resources to support rapid risk assessments of new emerging non-native species, to strengthen Australia's existing ability to mitigate the risks associated with invasive invertebrates.

Key words: Biosecurity, interception records, invasive invertebrates, non-native species, transport pathways



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Introduction

The global movement of invertebrates continues to intensify, with invasive taxa increasingly recognised as major drivers of biodiversity loss, ecosystem degradation, and the spread of pathogens (Dunn and Hatcher 2015; Morton et al. 2021; Zhang et al. 2022; Roy et al. 2024). Invasive non-native species are facilitated by expanding trade networks and international transport (Harfoot et al. 2018). As a global biodiversity hotspot, with a strong reliance on agricultural production, Australia faces unique challenges in managing non-native species (Clarke et al. 2018). Its geographic isolation and high rates of endemism compound the vulnerability

of Australia's environment to such incursions (Lach and Thomas 2008; Bradshaw et al. 2021). Non-native invertebrates pose a particularly severe threat as they can rapidly become invasive, devastate crops, disrupt pollination services, and introduce new pests and pathogens that threaten both public health and food security (Masan et al. 2012; Goulson and Hughes 2015; Marchante et al. 2021). The resulting financial burden on landholders, industries and conservation programs is substantial, with critical resources diverted to pest management, yield losses, and compliance with biosecurity regulations (Hoffmann and Broadhurst 2016; Bradshaw et al. 2021). Invasive invertebrates alone cost Australia up to 8 billion AUD annually, considering all losses and expenses (Hoffmann and Broadhurst 2016).

Australia's biosecurity framework is considered among the most robust globally and plays a central role in addressing these threats (Maru et al. 2025; Whattam et al. 2025). It is multilayered, with varying degrees of management across state, territorial, and federal levels, and activities are undertaken offshore, at the border, and onshore (Nelson et al. 2014; Whattam et al. 2024). Various stakeholders are involved, including all Australian governments, as well as industry, importers and exporters, and landholders (Aleri and Laurence 2020; Whattam et al. 2024). Central to this system is a holistic approach to preventing the establishment of invasive species, which includes pre-border risk assessments, border inspections and surveillance, and rapid responses to incursions (Ward 2015). Despite these efforts, new species continue to enter the country each year (Invasive Species Council 2017). Given nearly all incoming invertebrate incursions arrive via human-mediated pathways, Australia provides a model system for understanding international cross-border movement of invertebrates and offers valuable insights for other nations facing similar biosecurity challenges (Carrasco et al. 2010; Gippet et al. 2019; Turner et al. 2021). Although considered a world-class biosecurity system, the scale and complexity of introduction pathways necessitate ongoing evaluation to address potential vulnerabilities and maintain the effectiveness of the Australian system (Clarke et al. 2018).

Despite increasing attention on biological invasions, understanding the mechanisms and pathways of non-native species' introductions is a complex and ongoing challenge (Goldson et al. 2016; McKirdy et al. 2019). The extent of global trade, the cryptic nature of many invasive species, and the diversity of introduction pathways challenge effective monitoring and prevention efforts (Invasive Species Council 2017; Gippet et al. 2019; Turner et al. 2021). Monitoring the transport of terrestrial invertebrates comes with unique barriers, typically including their small body size and allusivity, their ability to survive long transit periods through adaptive mechanisms such as diapause and aestivation, and the general lack of scientific data and identification resources across all invertebrate taxa (Cardoso et al. 2011; Goldson et al. 2016; Almeida et al. 2017). Furthermore, the transport of species can occur accidentally (i.e., as hitchhikers or those travelling with host commodities), or intentionally (i.e., through wildlife trade) (Toy and Newfield 2010; Bush et al. 2014; Kumschick et al. 2016). Post-border pest management incurs higher costs compared to preventing the arrival of non-native species, and newly detected invasions are often already beyond the point of effective control (Hulme 2006; Welsh et al. 2021). Therefore, identifying prominent transport pathways remains important for mitigating invasion risk, alongside ameliorative efforts to prevent these organisms from reaching the Australian border (Campbell et al. 2007).

Propagule pressure, a measure of introduction intensity, is a key factor influencing an organism's likelihood of successfully establishing in a new environment

(Lockwood et al. 2005; Cassey et al. 2018). However, for many non-native species, the spatial extent and magnitude of their introductions remain unknown, leaving no direct way to quantify their propagule pressure (Lockwood et al. 2019). As globalisation and free trade continues to facilitate the spread of non-native species, there is growing interest in assessing establishment risks through trade pathways (Work et al. 2005; Suhr et al. 2019). While previous studies have shown that interception records are not reliable predictors of insect incursion risk (Caley et al. 2015; Nahrung and Carnegie 2021), the extent to which interception frequencies reflect propagule pressure for other non-native invertebrate taxa in Australia remains uncertain.

Due to the continuously growing diversity of taxa transported globally, biosecurity measures cannot be a one-size-fits-all, and are required to evolve over time (Hulme 2009; Stringham et al. 2021). Understanding and continuously monitoring high-risk pathways, species diversity, and trading ‘hot spots’ for export and import is essential for developing targeted and adaptive biosecurity strategies that remain effective over time. Despite Australia’s strong biosecurity framework, there has been limited comprehensive analysis of long-term interception data encompassing the wide diversity of terrestrial invertebrate taxa. While previous studies have drawn on interception records, they have typically focused on shorter time frames or on narrower groups, most often insects, leaving broader patterns across the full terrestrial invertebrate fauna unexplored (Caley et al. 2015; Suhr et al. 2019; Nahrung and Carnegie 2021; Turner et al. 2021).

Using a nine- year dataset of Australian interception records (2016–2024), we present the first national, cross-taxonomic assessment of terrestrial invertebrate interceptions, identifying changes in interception frequency, trade routes, and taxonomic diversity over time. Our objectives were to improve understanding of the transport pathways by which non-native invertebrates enter the country, identify the taxa and pathways posing the greatest management importance, and examine how these patterns have changed over nine years. Specifically, we: (1) analysed temporal trends in interception frequency across different movement types and transport pathways, including during the COVID-19 pandemic; (2) assessed the influence of incoming passenger numbers, international mail volume, air freight volume, and sea freight volume on interception rates; (3) explored the taxonomic diversity and identity of intercepted species to identify those posing the greatest potential biosecurity concern; and (4) investigated the geographic origins, transport modes, commodities, and detection locations of intercepted invertebrates. This study provides a data-driven overview of Australia’s biosecurity invertebrate interceptions, offering insights into the evolving challenges of managing invasive invertebrates in the context of global trade.

Methods

Data acquisition

Invertebrate biosecurity interception records (2016–2024) were requested and obtained from the Australian Department of Agriculture, Fisheries and Forestry (DAFF) incident client database. Data included invertebrate specimens intercepted at Australian national air and sea ports of entry and quarantine facilities, comprising a total of 178,887 interception records. Each record included information on the following: date; location of interception (state and city);

source country; transport vector (air/sea); movement vector (e.g., traveller, cargo, mail); associated commodities the invertebrates were transported with (e.g., fresh fruit, cut flowers, machinery); and identification to the lowest taxonomic level available (e.g., species, genus, family). A corresponding dataset of vertebrate interceptions was also obtained from DAFF.

Logistics data summarising imported air and sea freight volumes, mail volumes and number of inbound international airline passengers were acquired from freely available online resources published by the Australian Bureau of Infrastructure and Transport Research Economics (BITRE 2023, 2025). We also compared species within the interception dataset to The Australian National Priority List of Exotic Environmental Pests, Weeds and Diseases and the National Priority Plant Pest List (DAFF 2020).

Within this paper, all categories of interception data were taken directly from the DAFF interception dataset. This includes naming conventions for methods of transport type (air, sea) and movement types (e.g., mail, traveller). Limitations of the border interception data include the lack of information on import volumes and inspection rates, challenges in identifying invertebrates due to morphological variation between sexes (e.g., sexual dimorphism) and across life stages (e.g., concealed immature stages), difficulties identifying damaged specimens, and differences in interception rates and inspection methods between ports. Furthermore, interception data may reflect sampling bias, with greater scrutiny of high-risk goods like cut flowers and fruit, likely inflating the perceived risk of specific countries, commodities, trade routes, and taxa. Intercepted invertebrates were seized by DAFF, and potential risks of associated consignments were mitigated as part of their biosecurity protocols.

We did not have access to information on data collection procedures (e.g., sampling effort, inspection protocols, identification methods, or specific screening methods). Our analyses are based solely on the recorded interception data, and all interpretations and recommendations are drawn from the pattern's observable within this dataset. To present intercepted invertebrate diversity as a cladogram (Fig. 5), taxa were aligned with the National Centre for Biotechnology Information (NCBI) taxonomy database. All other taxonomic naming and common names are taken directly from the original data and used as-is through this study.

Data analysis and visualisation

We conducted all data analyses in the R software environment (R Core Team 2021) for statistical and graphical computing (version 2023.06.1) using the RStudio integrated development environment (Posit team 2025). For comparison of interception dynamics during the COVID-19 period, we classified each record as either a 'pre-COVID', 'COVID' or 'post-COVID' interception. Following Australian Government timelines and suggestions by prior studies, we defined 'pre-COVID' as 2016–2019, 'COVID' as 2020–2022, and 'post-COVID' as 2023–2024 (Evans 2022; Dakanalis et al. 2025). The use of mosaic plots allowed for the comparison of these time periods, constructed using the *ggalluvial* package (Brunson 2020). We constructed species accumulation curves using the *vegan* package (Oksanen et al. 2023), and extrapolated these using *iNEXT* (Hsieh et al. 2016). We retrieved taxonomic classification data from the NCBI taxonomy database using *ape* (Paradis et al. 2019), and visualised classification hierarchies with *ggtree* (Yu et al. 2017). For data wrangling and plotting, we used *dplyr* and *ggplot2*; both from the

tidyverse collection (Wickham 2016; Wickham et al. 2021). We enhanced figure labels using ggrepel (Slowikowski et al. 2018).

To calculate correlation coefficients between interceptions and introduction pathways, interception records were stratified by introduction pathway, and pathway-specific interception counts were plotted against their corresponding univariate pathway variables (Suppl. material 2). Pathway variables included incoming mail volume, incoming sea freight volume, incoming air freight volume, and the number of incoming passengers from international airlines. Associations were quantified using Spearman's rank correlation coefficients, reflecting non-linear, monotonic relationships and the skewed nature of interception data. Due to the availability of public data, interception data were aggregated by month for air freight, mail, and passenger numbers, and by calendar quarter (Q1 = January–March, Q2 = April–June, etc.) for sea freight, spanning the period 2018–2024.

We fit negative binomial generalised linear models to examine relationships between invertebrate interception frequencies and species diversity, using the MASS package (Ripley et al. 2013; Turner et al. 2021). Our analytical approach was informed by Turner et al. (2021), with modifications to suit the structure of the biosecurity data. Specifically, we tested (i) the number of interceptions per family compared to observed species richness, and (ii) the number of interceptions per family in relation to the number of globally described species per family. Global species richness estimates were obtained from the Catalogue of Life (Catalogue of Life 2025).

Results

Temporal trends

A total of 107,030 interception incidences were recorded between 1st January 2016 – 26th September 2024. Many of these incidences included multiple taxa ($n = 40,112$), resulting in 178,887 unique taxa-incident combinations. For the purpose of this study, we treated each combination as a unique specimen-interception record (termed 'interceptions' hereafter).

The greatest number of interceptions occurred in 2019 ($n = 26,650$), while the least were recorded in 2021 ($n = 15,395$). Interceptions exhibited a decline in 2020 followed by a gradual increase in subsequent years (Suppl. material 1: fig. S1A). This decline aligns with the impacts of the COVID-19 pandemic, during which Australia closed its international border to travellers on the 20th March 2020, and international import and export restrictions were introduced (Stobart and Duckett 2022). Seasonal fluctuations were evident in most years, indicating temporal patterns in interception activity (Suppl. material 1: fig. S1B).

Transport of intercepted organisms was primarily facilitated by the movement of cargo (79.3%), followed by travellers (12.6%), vessels (4.7%), and mail (3.3%) (Fig. 1A). The mode of movement could not be reliably determined for the remaining 0.1%. Between 2018 and 2024 the dominance of cargo showed a gradual decline. The majority of intercepted invertebrates arrived at the Australian border via air (56.4%), and sea (38.4%). The mode of transport could not be reliably determined for the remaining 5.2% (Fig. 1B). From 2016–2019 (pre-COVID), air was the dominant mode of transport, whereas from 2020–2022 (during COVID), sea transport became more prevalent.

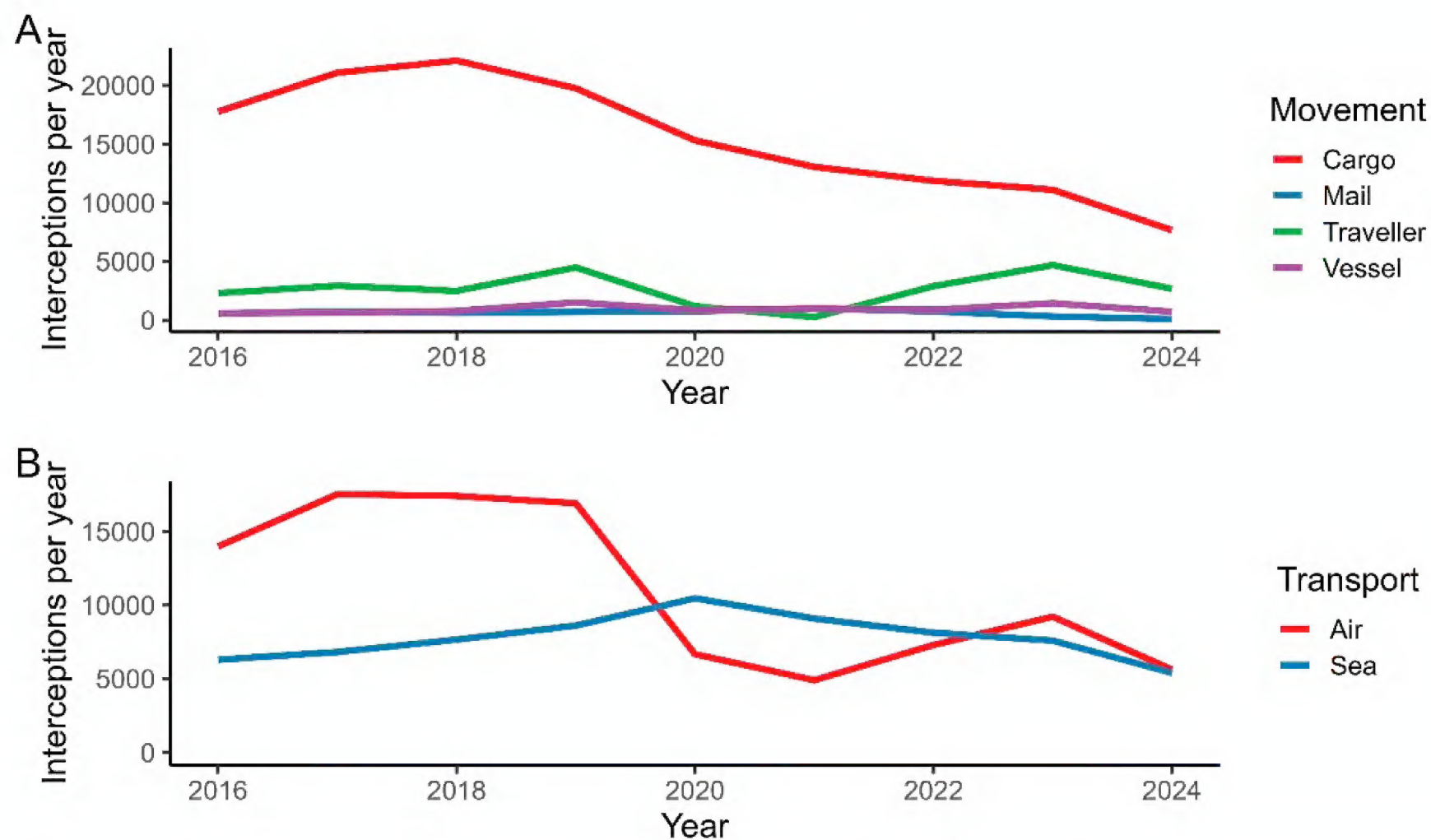


Figure 1. Temporal trends in terrestrial invertebrate interceptions in Australia from 2016 to 2024, categorized by **A.** Movement type (cargo, mail, traveller, and vessel), and **B.** The transport vector of intercepted invertebrates (air or sea).

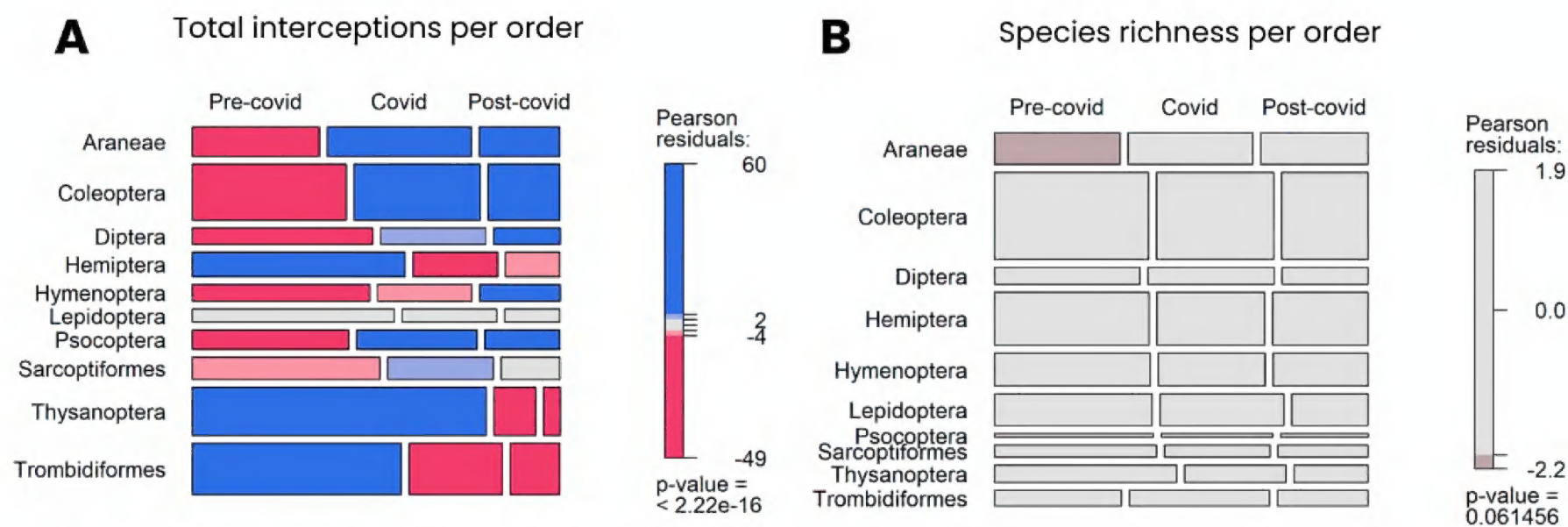


Figure 2. Comparison of interception dynamics over Pre-COVID (2016–2019), COVID (2020–2022) and Post-COVID (2022–2024) periods. Plots include the top 10 most intercepted invertebrate orders, and each order’s respective interception frequency (**A**) and the number of unique species intercepted per order (i.e., species richness) (**B**). Pearson residuals are displayed using a diverging colour scale. Panel **A** incorporates data from all recorded interceptions from the 10 most frequently intercepted orders. Panel **B** incorporates data from all interception records of these 10 orders that were identified up to species level. In each panel, the width of each bar represents the relative total number of records for a given order, while the height of each segment represents the proportion of records within that order occurring in each time period. The area of each rectangle is proportional to the total number of observations for that order-period combination.

For the 10 most frequently recorded invertebrate orders, patterns of invertebrate interceptions differed across pre-, during-, and post-COVID periods. While the total number of interceptions differed significantly among invertebrate orders over these time periods (Fig. 2A), species diversity within each order remained relatively stable over time (Fig. 2B). Thysanoptera, Trombidiformes and Hemiptera were intercepted more frequently prior to COVID compared to their interception numbers during and post-COVID, while interceptions of Araneae increased slightly during the COVID period. Thysanoptera, Trombidiformes and Hemiptera were intercepted less post-COVID than they were pre-COVID.

Statistical models for influences on interception frequency

Data were aggregated by month for all passenger, air freight and mail interceptions, and by yearly quarter (e.g., Q1 = January - March, Q2 = April - June) for sea freight. Correlations between interception frequency and pathway-specific transport volumes were visualised with plots of raw data count data, and quantified using Spearman's rank correlation coefficients (ρ) (Fig. 3). A moderately strong positive association was observed between the number of incoming passengers and interception frequency ($\rho = 0.66$, $p = 3.0007\text{e-}11$, $n = 23550$ interceptions), indicating that higher passenger volumes were generally associated with higher numbers of invertebrate interceptions. In contrast, interception frequency showed a weak association with mail volume ($\rho = 0.35$, $p = 0.0016$, $n = 5760$ interceptions), and no evidence of association with air freight volume ($\rho = 0.02$, $p = 0.857$, $n = 75720$ interceptions), and sea freight volume ($\rho = -0.14$, $p = 0.499$, $n = 61965$ interceptions).

Invertebrate identification and diversity

From the 178,887 unique interceptions, 40.5% were identified to the taxonomic level of species. A total of 2,414 unique species were intercepted at the Australian border over the 9-year period (Table 1). Of those, 46% were intercepted only once ($n = 1,111$). Despite this diversity, 4.5% of species ($n = 108$) made up almost one third (32%) of all 178,887 interceptions. With only 40.5% of all interceptions identified to species level, it is likely that many more species were intercepted at the border but not recorded at species level. We acknowledge that identifications may be influenced by prioritisation, with some species given greater attention due to their perceived risk, while others are identified only to a higher taxonomic level when further resolution is not considered necessary for biosecurity decision-making.

The number of new species intercepted at the Australian border increased over time and did not reach an asymptotic plateau, even when extrapolated to twice the observed sampling effort (Fig. 4A). Similarly, the number of new genera recorded in the interception dataset continued to increase without plateauing (Fig. 4B).

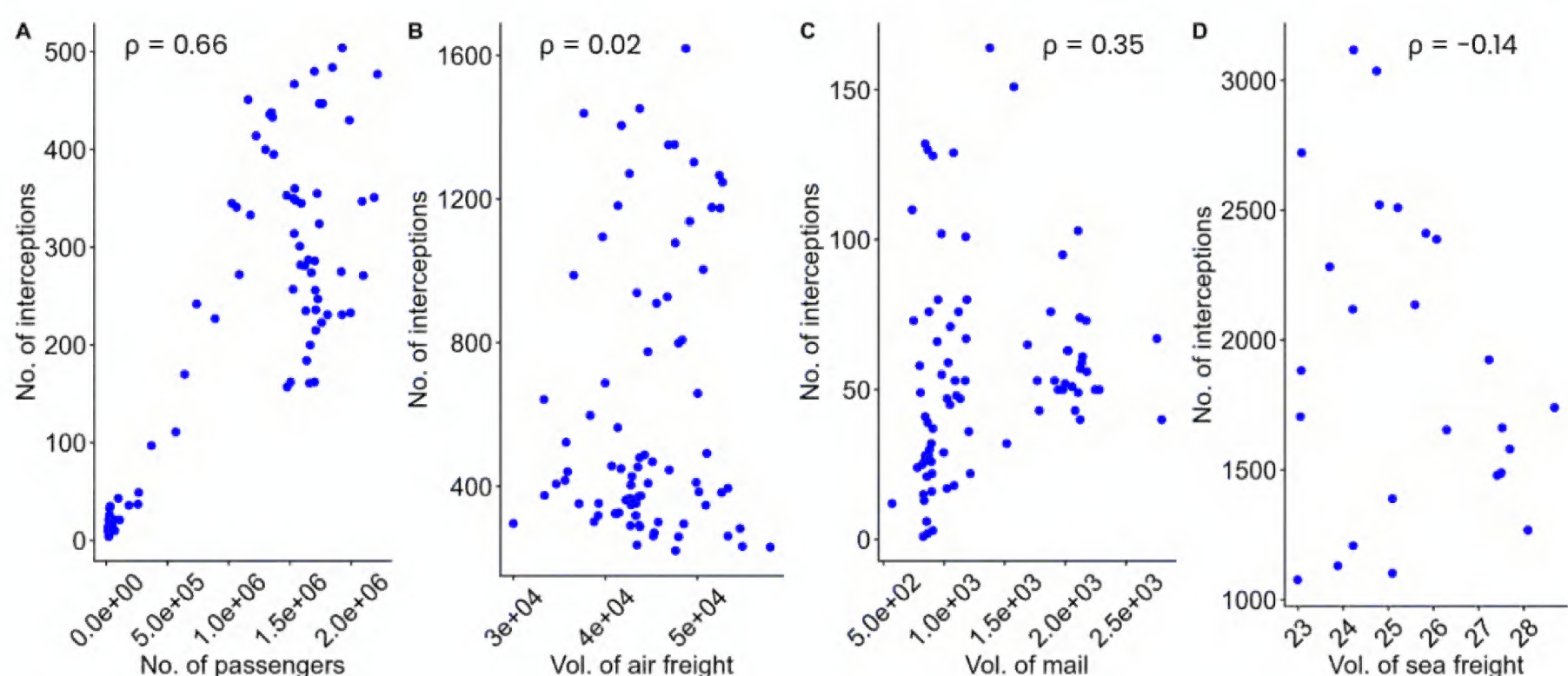


Figure 3. Correlations between the number of invertebrate interceptions and **A.** Incoming passenger numbers; **B.** Air freight volume (tonnes); **C.** International mail volume (tonnes) and **D.** Sea freight volume (million tonnes). Points represent raw data showing the total number of interceptions per month in panels **A**, **B**, **C**, and total number of interceptions per quarter in panel **D**.

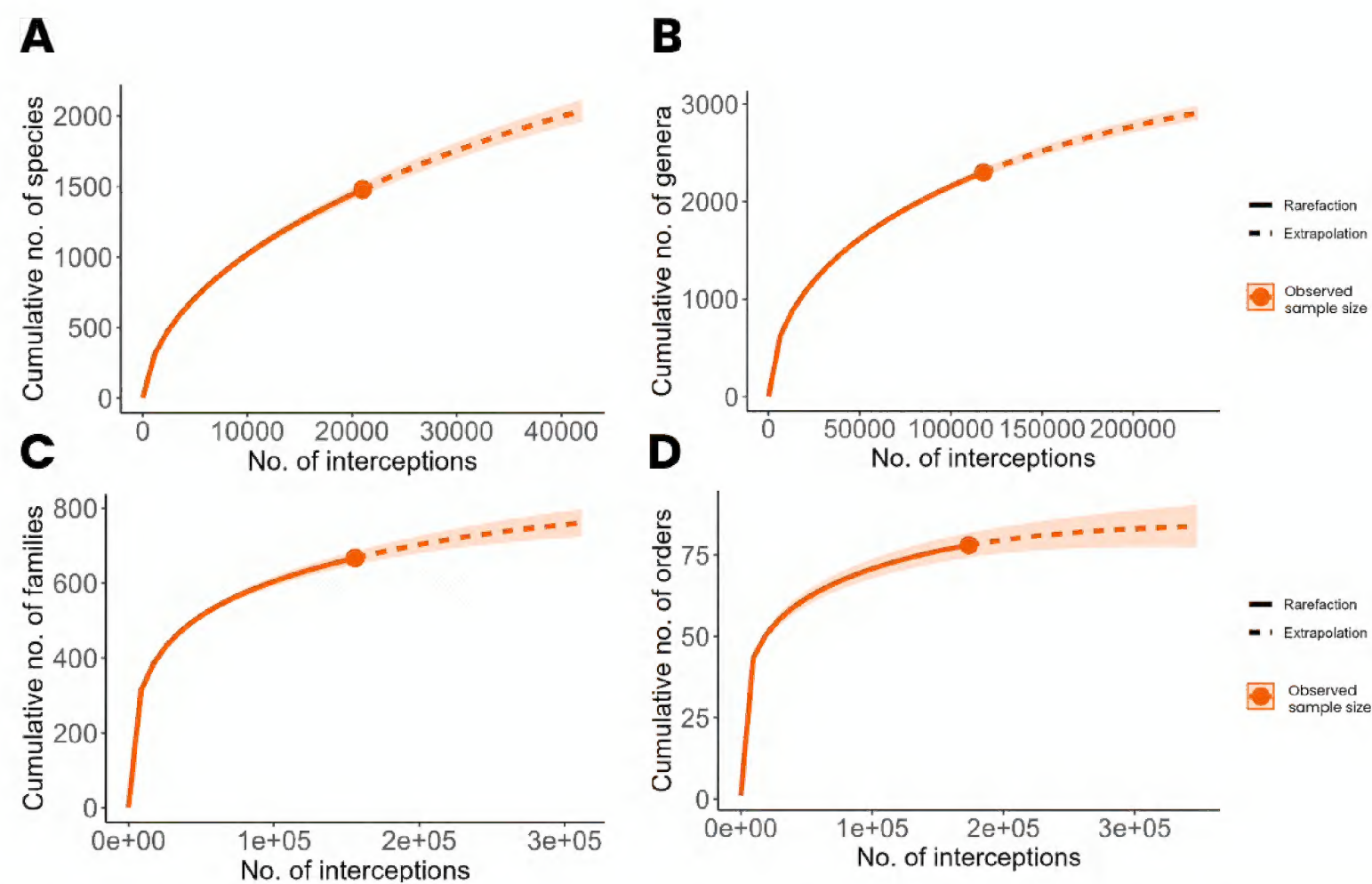


Figure 4. Sample-size based rarefaction and extrapolation curves showing the cumulative number of unique invertebrate taxa intercepted at the Australian border (as identified by DAFF) between 2016 and 2024, plotted as a function of the number of interceptions. Curves are shown for records identified to **A.** Species level; **B.** Genus level (including genera from species-identified records); **C.** Family level, and **D.** Order level. Solid lines represent rarefaction within the observed sample size, dashed lines represent extrapolation beyond the observed sample size, and shaded areas indicate 95% confidence intervals. Filled points indicate the observed sample size for each taxonomic level.

Table 1. The unique number of taxa identified at each taxonomic level, and the number of interceptions for which that level represented the finest taxonomic resolution of identification. The unique taxa recorded is hierarchical, where the species are nested within the listed genera, and genera within the listed families. Interception counts by taxonomic rank are mutually exclusive and sum to the total number of interceptions overall.

Finest level of identification	Unique taxa recorded at this level	Number of interceptions identified up to this level
Species	2,414	72,554
Genus	2,300	45,303
Family	668	37,996
Order	79	17,854
Class	21	4,802
Phylum	5	378
Total no. of interceptions		178,887

In contrast, the rate of new families recorded at the border began to plateau (Fig. 4C), while the number of new classes reached an asymptotic plateau, indicating a saturation of identifications at this taxonomic level (Fig. 4D).

Recorded interceptions encompassed a broad diversity of terrestrial invertebrate lineages across five phyla, including Annelida, Arthropoda, Mollusca, Nematoda and Platyhelminthes. Insects were most abundant in the interception data, followed by arachnids and gastropods (Fig. 5). The most frequently intercepted orders were Coleoptera, Trombidiformes, and Thysanoptera, each with more than 25,000 interceptions recorded over the nine-year period.

The most frequently recorded species from 2016 to 2020 was *Frankliniella occidentalis* (Fig. 6). In 2021 and 2023, *Lasioderma serricorne* (Coleoptera:

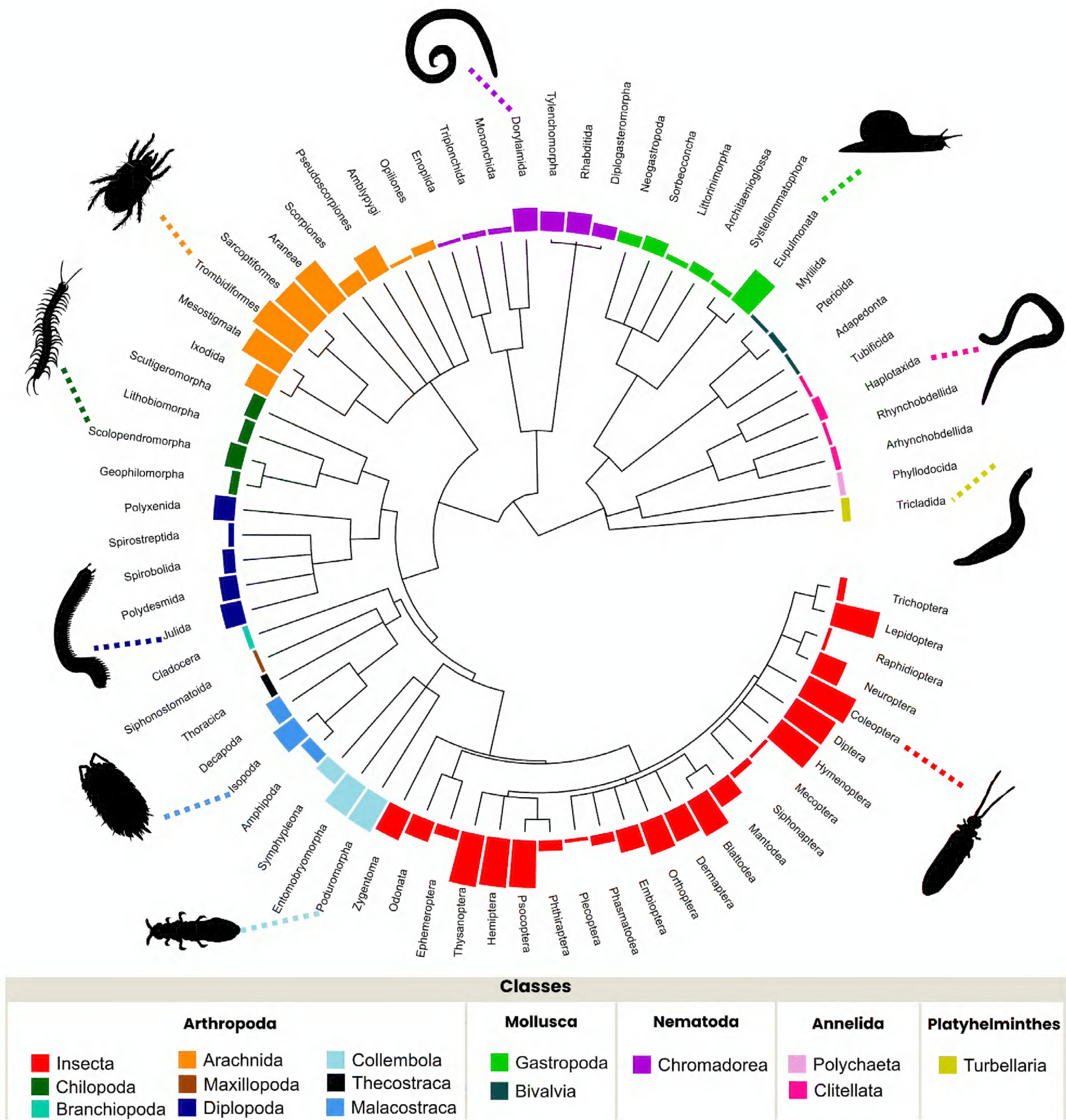


Figure 5. A taxonomic cladogram depicting frequency of invertebrate orders intercepted at the Australian border, and their taxonomic hierarchy with equal branch length. Bar height indicates the total number of interceptions, and colour indicates the class from which they reside. Silhouettes link to the top 10 most abundant classes (illustrating frequently intercepted genera within each class). Clockwise from top: *Aphelenchoides*, *Cornu*, *Perionyx*, *Platydemus*, *Lasioderma*, *Xenylla*, *Porcellio*, *Ommatoiulus*, *Scolopendra*, *Cheyletus*. Silhouette images were sourced from PhyloPic (Keesey (2025); provided by Birgit Lang (*Porcellio* sp.); Christoph Schomburg (*Cheyletus*); Gemma Martínez-Redondo (*Ommatoiulus*); Mali’o Kodis, image from the Smithsonian Institution (*Aphelenchoides*); Markus A. Grohme (*Platydemus*); RS (*Perionyx*); Takahashi (modified by T. Michael Keesey) (*Lasioderma*); Yan Wong from photo by Denes Eموke (*Cornu*); and others (*Xenylla*, *Scolopendra*).

Anobiidae; tobacco beetle) was the most frequently intercepted invertebrate assigned a species level identification, while in 2022 and 2024, *Ahasverus advena* (Coleoptera: Silvanidae; foreign grain beetle) was the most intercepted species. Across the entire dataset, the taxon most frequently assigned a named identification, at the finest level to which records were resolved, was *Tetranychus* spp.

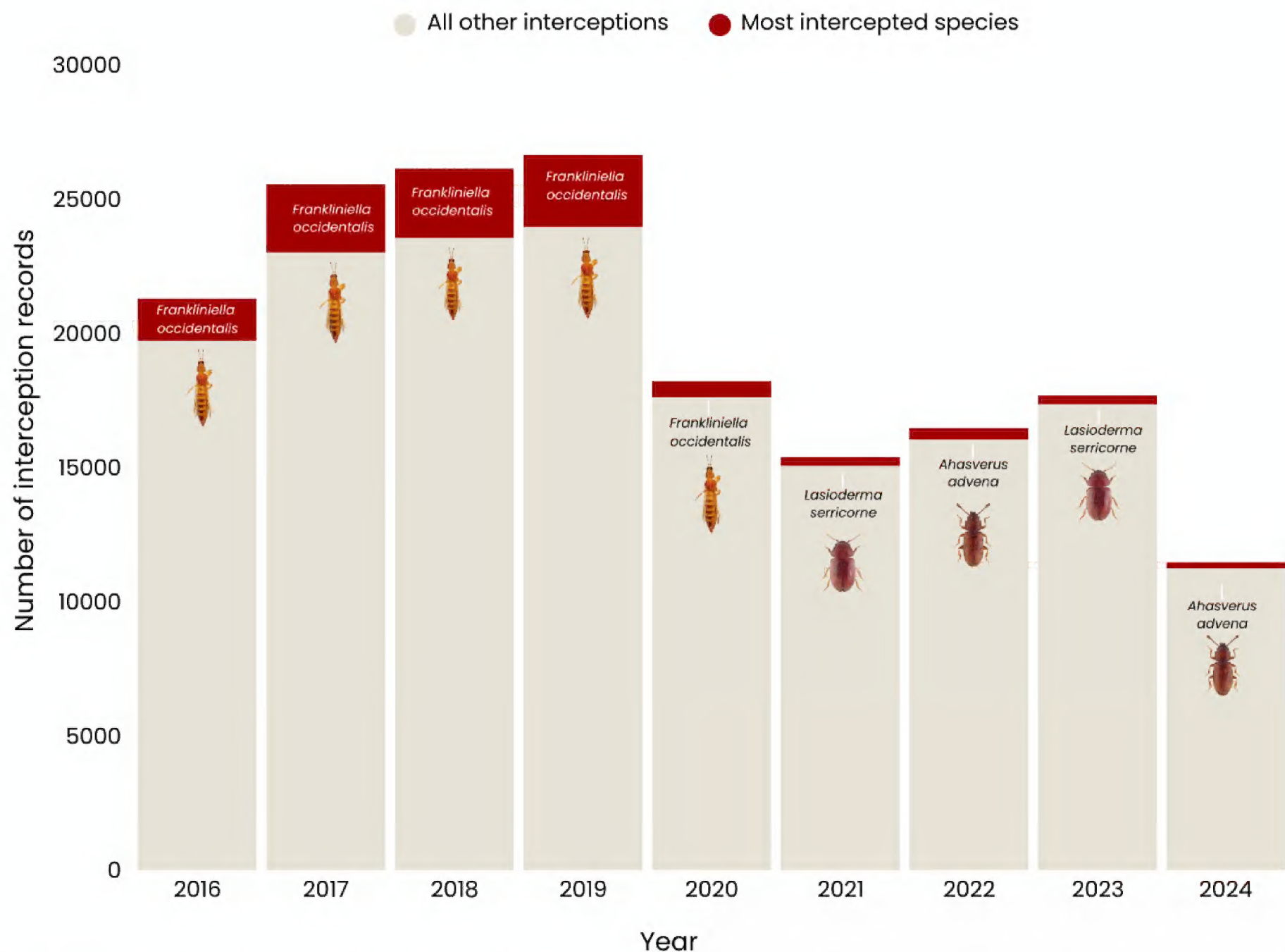


Figure 6. The total number of invertebrate interceptions at the Australian border each year, between 2016 and 2024 (note that data from 2024 is incomplete, only entailing interception incidences up to September). For each year, the proportion of interceptions pertaining to the most frequently intercepted invertebrate species is coloured in red. Images within the bars depict the most frequently intercepted species each year. Species images were sourced from Bugwood.com, under the Creative Commons Attribution 3.0 License. Images were provided by David Cappaert (*F. occidentalis*), Pest and Diseases Image Library (*L. serricorne*), and Emilie Bess USDA Animal & Plant Health Inspection Service (*A. advena*).

(Trombidiformes: Tetranychidae; spider mites). The large proportion of interceptions identified only to genus level (e.g., *Tetranychus* spp.) may reflect a combination of both diagnostic limitations and/or risk assessment and decision-making processes by entomologists, rather than true species diversity.

The relationship between interception frequency and taxonomic diversity varied across invertebrate families and orders. At the family level, a positive relationship was observed between the number of intercepted species and the total number of interceptions ($\beta = 1.45$, $p < 0.001$; Fig. 7A). Several families, such as Formicidae, and Pentatomidae, exceeded predicted interception counts based on their species richness within the interception records. At the order level, the effect of global species numbers of interception frequency was positive but not significant ($\beta = 0.35$, $p = 0.059$; Fig. 7B). Some orders, including Hemiptera and Araneae, were intercepted more frequently than expected based on their global diversity. In these cases, a taxon's interception frequency may be more closely attributed to other factors, such as their likelihood to hitchhike. Furthermore, the number of global species per order was not a significant predictor of interception frequency ($\beta = -0.08$, $p = 0.50$; Fig. 7C), suggesting that factors beyond taxonomic richness may drive interception frequency.

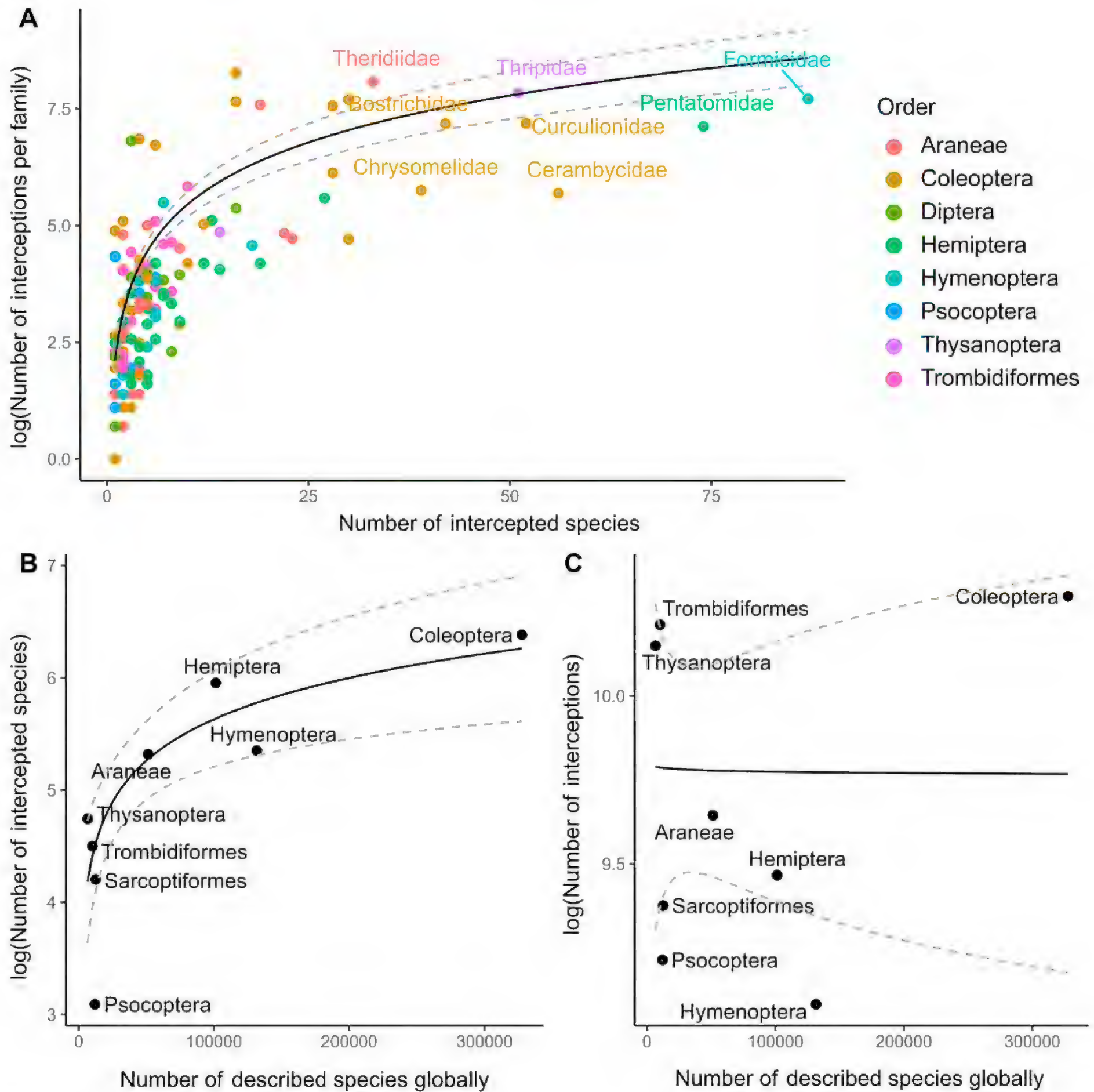


Figure 7. Number of interceptions for the top eight intercepted invertebrate orders (making up 79% of all interceptions): Araneae, Coleoptera, Diptera, Hemiptera, Hymenoptera, Psocoptera, Thysanoptera, and Trombidiformes, for interceptions identified to species level. **A.** Observed number of interceptions per family (log-transformed) plotted against the number of intercepted species per family. Families with more than 100 interceptions and over 30 described species are labelled; **B.** Observed number of intercepted species per order (log-transformed) plotted against the number of described global species per order; **C.** Total number of interceptions per order (log-transformed) plotted against the number of described global species per order. For **A**, **B**, **C**, the solid line shows the fit of a negative binomial regression model, with dashed lines indicating 95% prediction bounds (on the link scale). The number of global species is sourced from the Catalogue of Life (Catalogue of Life 2025).

Commodity trends

To identify commodity pathways posing the greatest concern of invertebrate introduction, we examined the association between interceptions, identifications, and declared import commodities. Overall, 61.5% of all interceptions were associated with plant product commodities ($n = 117,401$). Of these, 94% were fresh plant products ($n = 110,154$, e.g., fruit, vegetables, live plants, cut flowers), and 6% were

Table 2. The top three commodity types most frequently associated with intercepted invertebrates, the overall diversity of taxa identified, and the finest levels of identification assigned to intercepted individuals.

Commodity group	Finest level of identification	Unique taxa recorded at this level	Interceptions identified up to this level	% of commodity group interceptions	Total no. of interceptions
Plant products	Species	1,318	40,177	34.2%	117,401
	Genus	1,221	34,860	29.7%	
	Family	469	24,932	21.2%	
	Order	55	12,867	11%	
	Class	18	4,227	3.6%	
	Phylum	5	338	0.3%	
Wood products	Species	563	5,751	37.6%	15,283
	Genus	599	3,390	22.3%	
	Family	300	3,931	25.7%	
	Order	45	1,978	12.9%	
	Class	12	216	1.4%	
	Phylum	4	17	0.1%	
Animal products	Species	279	4,261	66.2%	6,435
	Genus	272	1,101	17.1%	
	Family	203	754	11.7%	
	Order	43	264	4.1%	
	Class	14	52	0.8%	
	Phylum	4	3	0.05%	

dried plant products (n = 7,247, e.g., dried herbs, spices, dried fruit, dried flowers). A further 8.5% of interceptions were associated with wood product commodities (n = 15,283, e.g., timber, furniture, bamboo products), and 3.6% were associated with animal product commodities (n = 6,435, e.g., live animals, dried meat, skin and fur, preserved insects). For 14.2% of interceptions (n = 25,354), there was either no commodity recorded or no commodity associated.

Plant products were associated with the highest number of unique species intercepted at the border (n = 1,318 species; Table 2), whereas far fewer species were intercepted with wood products (n = 563 species) and animal products (n = 279). The level of identification applied to intercepted invertebrates varied considerably between the associated commodity types. While roughly one third of interceptions associated with plant and wood products were identified to species level (34.2% and 37.6%, respectively), 66.2% of those associated with animal products were identified to species level (Table 2). We acknowledge that interception data may be influenced by uneven sampling effort across commodity types, with heightened scrutiny of high-risk commodities, such as fresh plant products and live animals, likely contributing to higher detection rates within particular commodity types and taxonomic groups (Department of Agriculture 2019; Department of Agriculture Environment and Water 2021).

Species accumulation curves for the three main commodity types associated with interceptions show no signs of plateauing, even when extrapolated to twice the observed sampling effort, indicating ongoing detection of new taxa transported with plant products, wood products and animal products (Fig. 8).

Spatial trends

The greatest number of invertebrate interceptions occurred at commonwealth inspection facilities located in New South Wales (n = 64,368), Queensland (n = 50,579), and Victoria (n = 37,820). These same jurisdictions also recorded the highest species

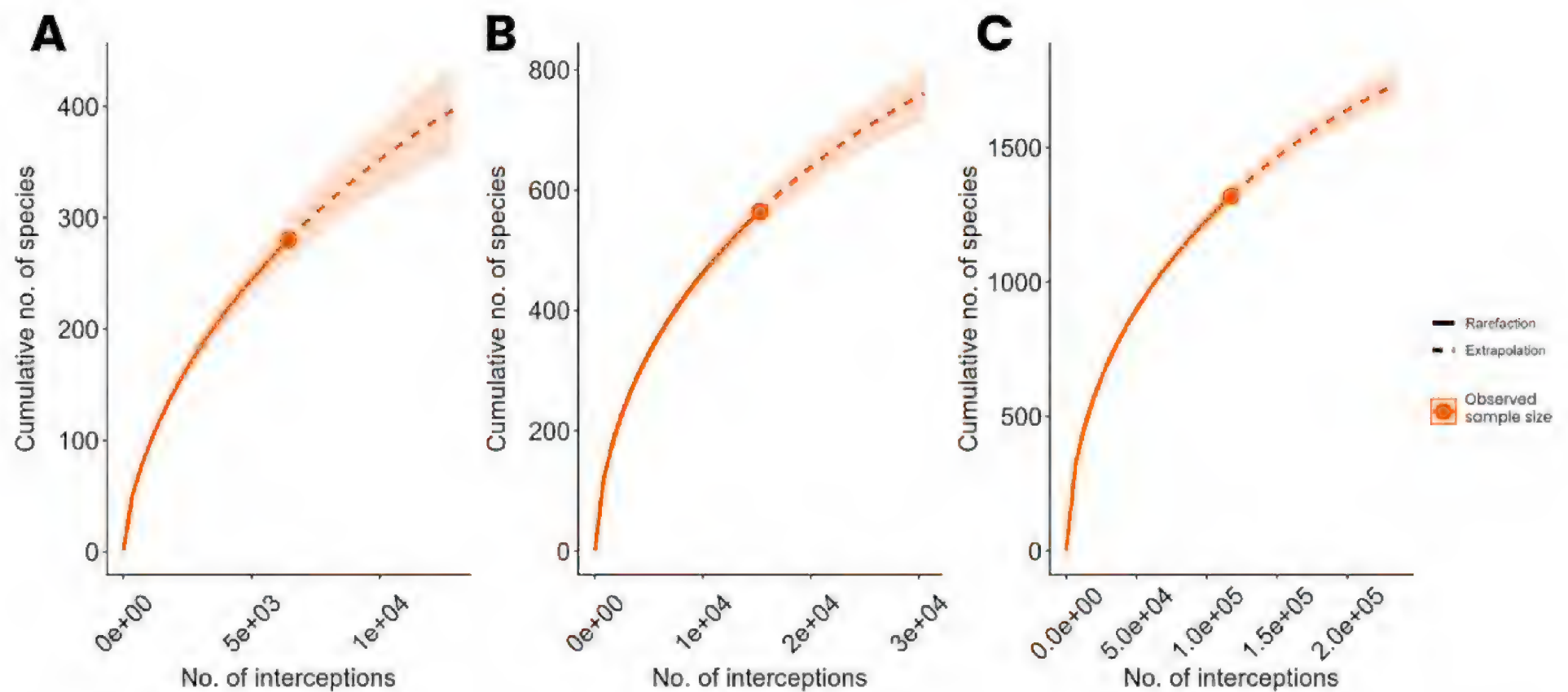


Figure 8. Sample-size based rarefaction and extrapolation curves showing the cumulative number of unique invertebrate species intercepted at the Australian border (as identified by DAFF) between 2016 and 2024, transported alongside **A.** Animal product commodities; **B.** Wood product commodities, and **C.** Plant product commodities. Solid lines represent rarefaction within the observed sample size, dashed lines represent extrapolation beyond the observed sample size, and shaded areas indicate 95% confidence intervals. Filled points indicate the observed sample size for each associated commodity type.

diversity, with 839 species intercepted in New South Wales, 838 in Queensland, and 814 in Victoria (Suppl. material 3). Intercepted invertebrates travelled from 185 countries, representing all human-populated continents. While 57% of interceptions had no reported region of origin in the dataset ($n = 102,594$), the greatest number of records originated from Asia (16.1%, $n = 28,823$), Oceania (10.5%, $n = 18,714$), and Africa (5.2%, $n = 9,287$; see Suppl. material 4 for all regions).

Border interceptions of priority pests and exotic species

Twelve intercepted species are listed as a national priority pest species in Australia, under the National Priority List of Exotic Environmental Pests, Weeds and Diseases (EEPL; Suppl. material 5). This represents half of all invertebrate species currently listed under the EEPL. Of these 12 species, six are included in the Higher-risk Exotic Environmental Pest List, as species that are not established in Australia and pose the highest risk to the environment and public spaces (DAFF 2020). *Harmonia axyridis* ($n = 109$, Multi-coloured Asian lady beetle), *Solenopsis invicta* ($n = 36$, Red imported fire ant), and *Coptotermes formosanus* ($n = 17$, Formosan subterranean termite) were the most frequently intercepted high risk exotic environmental pest species (from the EEPL). Additionally, 20 invertebrate taxa included on the National Priority Plant Pest List (NPPPL) were intercepted at the Australian border. The most frequently intercepted plant pest taxa (from the NPPPL) were *Halyomorpha halys* ($n = 476$; brown marmorated stink bug), *Erthesina fullo* ($n = 202$, stink bug), *Trogoderma granarium* ($n = 119$; khapra beetle), and *Lissachatina fulica* ($n = 100$; giant African land snail).

Additionally, eight live non-native arachnids were intercepted alongside four live non-native reptiles. These included *Heterometrus spinifer* ($n = 2$, Malaysian rainforest scorpion), *Brachypelma smithi* ($n = 2$, Smith's redknee tarantula), *Megaphobema robustum* ($n = 2$, Columbian giant tarantula), and *Lasiadora parahybana* ($n = 2$,

Brazilian salmon tarantula), which were transported with *Python regius* (ball python), and separately with *Tropidolaemus wagleri* (Wagler's pit viper). These consignments were not associated with any declared commodity, and interception commodity was labelled as "live animal." All of these intercepted species are well-documented in the international exotic pet trade, although they were not explicitly labelled as instances of illegal invertebrate smuggling in the interception dataset.

Discussion

While invertebrates are crucial to the functioning of their native ecosystems, they can be ecologically and economically devastating when introduced beyond their natural range. Invasive terrestrial invertebrates cause widespread environmental and societal damage, imposing substantial costs. The impact of insects alone globally is estimated at US\$70 billion per year in damage to goods and services (Bradshaw et al. 2016; Renault et al. 2022). This includes health costs related to the spread of disease, financial losses, and eradication methods to control the consumption of crops, and damage to infrastructure (Bradshaw et al. 2016).

Using nine years of national interception data, we provide a comprehensive overview of terrestrial invertebrates arriving at Australian borders via international trade, vessels, mail, and passenger travel. Our analyses revealed clear spatial and temporal patterns in interception frequency, relationships between interception frequency and commodity type, shifts in the taxonomic composition of intercepted taxa before, during and after COVID-19, and transport pathways most frequently associated with invertebrate arrivals. Together, these findings offer valuable evidence to inform biosecurity practices and policy, highlighting priority pathways and time periods where risk may be elevated. The patterns observed here also have broader relevance for countries facing similar biosecurity challenges, contributing to global efforts to understand and mitigate the movement of non-native invertebrates through international trade networks.

Temporal trends

Seasonal patterns in invertebrate interception records display a recurring influence of temporal drivers, with interception peaks occurring between November and February and declines between May and July (Suppl. material 1). These trends may reflect seasonal changes in trade activity, travel volume, and possibly biological factors such as species phenology (e.g., overwintering behaviour of northern hemisphere species) or life stage availability during transit. Importantly, it is likely that these seasonal peaks are jointly driven by both pathway activity and climate. For instance, the Australian summer corresponds with the peak tourism season and increased international mail volumes, including from northern hemisphere countries where tourists may be escaping winter conditions (BITRE 2025). Furthermore, warmer temperatures and higher humidity levels within Australia during the summer months may increase invertebrate activity, reproduction, and transport risk (Leith et al. 2021; Hunn et al. 2024; BITRE 2025). Future research should account for geographic differences in seasonality between regions of origin and Australia, as seasonal cycles differ between the northern and southern hemispheres.

Notably, this temporal pattern persisted even during the COVID-19 pandemic years (2020–2022), despite an overall decline in interception numbers (Suppl.

material 1). This decline aligns with Australia's international border closure in March 2020 and the broader global disruptions caused by the pandemic, including a dramatic reduction in passenger arrivals and major interruptions to freight supply chains (Munawar et al. 2021). The increase in freight costs and reduced shipment frequency may have directly affected interception opportunities. Additionally, changes in inspection priorities or resource allocation at borders during the pandemic could have influenced detection rates across pathways or commodity types. Although interception rates have gradually recovered since 2021, they had not, by 2024, returned to the levels observed prior to the pandemic, even though mail, cargo, and passenger numbers had (BITRE 2025). This suggests that long-term changes in trade or travel behaviour, or improvements in pre-border risk management, may be continuing to influence interception frequencies.

Changes were also seen in the frequency and diversity of species intercepted before, during, and after the COVID-19 pandemic. While the number of interceptions per order differed significantly across the three periods (pre-, during, and post-COVID), the diversity of species within each order remained relatively consistent. The consistent species diversity observed across pre-, during, and post-COVID periods, combined with the continual accumulation of previously unrecorded species, suggests that although the specific taxa being intercepted change over time, the rate at which new species enter interception records remain relatively constant. This also implies consistent biosecurity threats, even if trade volumes fluctuate. Differences in interception frequency among orders over these time periods may reflect variation in both species' ecological traits, and changes in import types and volumes in Australia. For example, orders Hemiptera and Thysanoptera are known to have a strong association to plant product commodities, and these orders were intercepted more frequently before the COVID pandemic. Declines in Thysanoptera and Hemiptera relative to pre-COVID may be attributed to the decline of interceptions through air transport (Fig. 1), or changes in offshore biosecurity measures, including enhancements to cut flower import practices (Jones and Leather 2012; Department of Agriculture 2019; Department of Agriculture Environment and Water 2021; Kent et al. 2022). Access to detailed records of commodity-specific import volumes could help clarify these patterns, and determine the driving factors behind the geographical distribution of interceptions nationally. While these taxa-commodity relationships have been documented in other geographic settings (Nentwig 2015; Nahrung and Carnegie 2021; Saccaggi et al. 2022), further research should explore the relationship between particular taxa and commodity types entering Australia.

Transport pathways

Between 2016 and 2024 Australia imported more than 878 million tonnes of sea freight from international suppliers (Ports Australia 2025), and received more than 128 million inbound passengers via international airlines (BITRE 2025). Comparisons between raw interception counts and volumes of incoming freight, mail, and passenger movements revealed a moderately strong positive association between interception numbers and passenger arrivals. Interception frequency tended to increase with higher passenger numbers, whereas associations with air freight, sea freight, and mail volumes were inconsistent. Given limited data availability on import volumes (i.e., only monthly and quarterly summaries), these patterns were explored using plots of raw count data, and quantified with Spearman's correlation coefficients.

Although increased volumes of imported freight, mail, and passengers might be expected to result in higher interception frequencies, our findings do not support this assumption. With the exception of passenger movements, the volume of incoming mail and freight alone does not appear to be a primary driver of interception frequency or associated biosecurity risk. Instead, interception frequencies may be influenced by a range of other ancillary variables not captured in this analysis, including inspection effort, inspection methods, biosecurity prioritisation, and an invertebrate's likelihood of hitchhiking on, and surviving transport with, specific commodities and transport vessels. Incorporating these variables into future quantitative models and pathway-specific risk assessments would improve inference. Nonetheless, these findings highlight the importance of maintaining targeted inspection strategies tailored to pathway-specific risks, with particular emphasis on incoming passengers.

Weak relationships between interception frequency and transport volumes may also reflect risk-based inspection frameworks. Under the Australian Biosecurity Act 2015 (Cth), commodities are subject to import risk assessments that determine the specific biosecurity measures required for them to meet the nations Appropriate Level of Protection. Inspections are then conducted to verify compliance with those measures, and often, only a small proportion of the total volume of goods are inspected. As such, inspection effort may be independent of overall freight, mail or passenger volumes. Consequently, higher proportions of low-risk consignments may result in reduced inspection effort and fewer interceptions, irrespective of transport volumes. The absence of clear relationships between interception frequency and air freight, sea freight, and mail volumes therefore suggests that targeted, risk-based inspection practices may have a stronger influence on interception outcomes than the sheer volume of imported goods.

Biosecurity risks associated with particular facets of global trade can be examined by exploring the commodity types associated with invertebrate interceptions. Our detection of associations between invertebrate interceptions with plant, wood, and animal products are consistent with other biosecurity studies, which have identified wood, plant and animal products as key pathways for the introduction of non-native invertebrates (Mound 2005; Liebhold et al. 2016; Suhr et al. 2019; Nahrung and Carnegie 2022; Fenn-Moltu et al. 2023). Importantly, new species identifications are ongoing across these commodity types - not just the repeated detection of previously recorded species. This trend highlights the ongoing risk of novel species introductions and underscores the importance of maintaining vigilant, pathway-targeted inspections. Future research should aim to integrate import volume to compare interception rates between different transport pathways standardised by the volume of associated vectors, strengthening risk assessments and allowing for more precise identification of high-risk trade sectors.

Additionally, detection rates are inevitably shaped by the resources, methods, and expertise applied during inspections (Suhr et al. 2019; Nahrung and Carnegie 2022). Inspection capacity varies with staffing levels, funding, and access to training and diagnostic tools, though without relevant data we were unable able to assess these potential covariates. As such, our interpretations are based solely on patterns observable in the interception dataset and may not fully reflect true incursion risk or detection efficiency. A better understanding of differences in inspection effort, and detection protocols among inspection facilities would help clarify whether current interception data reflect genuine variation in biosecurity risk or differences in inspection practice.

Regions of focus

Over half of all invertebrate interceptions occurred at facilities located in New South Wales (36%) and Queensland (28%); the first and third ranked states for volume of imported sea freight, respectively (Victoria ranks second), and both among the highest for international passenger arrivals (BITRE 2023). These figures reflect the increased biosecurity risks associated with major international entry points, particularly seaports and airports that facilitate high volumes of both people and goods. However, facilities with stronger entomological expertise, more comprehensive screening technologies, or better-developed reporting systems may detect and record more interceptions, not necessarily because of higher risk, but due to greater surveillance capacity. Additional factors such as state population size, proximity to major trading partners (e.g., New Zealand), and the frequency of inspections targeting particular commodities may also influence interception rates.

Taxonomic patterns and identification challenges

Interception data showed that nearly half (46%) of all intercepted species were recorded only once, while a small subset (4.5%) accounted for nearly one third (32%) of all interceptions. The abundance of particular species in invasion pathways may be influenced by a variety of factors. These may be: a) species' natural abundance in source regions, b) biological affinity to associate with traded goods, c) physiological resilience to environmental stressors, d) morphology leading to higher likelihood of detection (i.e., larger body size, bright colouration) (Gippet et al. 2019), or e) observer biases (i.e., more effort used to detect high-risk taxa). Furthermore, the composition of arriving invertebrates is influenced by the composition of trade commodities and origin countries for international travellers, mail and cargo. With new invertebrate taxa continuing to arrive at the Australian border over time, continued research and education in species identification, and resources for rapid risk assessments of newly emerging species and pathways are necessary.

We also encountered ambiguities in the taxonomic naming within the records. Many classifications were outdated or listed as synonyms (even considering the date they were recorded), incorrectly placed (i.e., order names recorded as genus names), or misspelled. Evidently, a national standardised taxonomic backbone across all states and research divisions is necessary to harmonise the data collected and reported.

The ease of species-level identification of intercepted specimens depends on a myriad of factors, including the available expertise, adequate personnel training, accessible identification resources such as keys, difficulties identifying damaged specimens, and advancement of molecular identification methods and the corresponding reference databases (Boykin et al. 2012; Moritz et al. 2020). This likely results in an underrepresentation of taxa that are less studied and have less-accessible identification resources, but which may still pose significant ecological risks (Watkins et al. 2021). Complicating matters further, many invertebrate groups in Australia remain poorly documented, with only a small proportion of the estimated diversity described (Taxonomy Decadal Plan Working Group 2018), making it difficult to determine whether an intercepted species is non-native or simply a scientifically undescribed native species. Hence, the true extent of invertebrate incursions and threats to biodiversity may remain underestimated. However, by highlighting key transport pathways and taxonomic groups, we can continue to

address knowledge gaps regarding the entry of these species into Australia and develop strategies for mitigating future incursions, as global trade demands and environmental landscapes continue to evolve.

Invasion risk and management implications

The interception of priority pest species at Australia's border is concerning, though not unexpected. These species are classified as priority threats because of their capacity to travel outside their native region and successfully establish in new, non-native environments. In many cases, their invasive potential has already been demonstrated through documented incursions in other countries. However, it is not just their presence at the border that warrants attention; it is the relative frequency of their interceptions that should be closely monitored. High interception rates may signal increased propagule pressure, raising the risk that some individuals will slip through undetected and establish viable populations (Lockwood et al. 2005; Caley et al. 2015). Six of Australia's twelve nationally declared priority pest species intercepted at the border pose particularly high environmental and economic risks due to their severe impacts overseas and strong capacity to establish locally. These include *Lymantria dispar* (spongy moth, $n = 8$), *Coptotermes formosanus* (Formosan subterranean termite, $n = 17$), *Lissachatina fulica* (giant African snail, $n = 100$), *Harmonia axyridis* (multi-coloured Asian lady beetle, $n = 109$), *Solenopsis invicta* (red imported fire ant, $n = 36$), and *Wasmannia auropunctata* (electric ant, $n = 28$), underscoring the ongoing pressure on Australia's biosecurity system.

In addition to accidental introductions, deliberate smuggling of exotic species poses an increasingly complex challenge for biosecurity authorities (Toomes et al. 2020; Lassaline et al. 2025). Several non-native arachnid species were intercepted alongside non-native reptiles, suggesting overlapping trade pathways likely associated with the exotic pet trade. This included *Heterometrus spinifer* (Malaysian rainforest scorpion), *Brachypelma smithi* (Smith's redknee tarantula), *Megaphobema robustum* (Columbian giant tarantula), and *Lasiadora parahybana* (Brazilian salmon tarantula), which were identified in consignments with *Python regius* (ball python), and separately with *Tropidolaemus wagleri* (Wagler's pit viper). These arachnid and reptile species are all recognized as having demand in the international wildlife trade (Mendoza and Francke 2017; Marshall et al. 2020; Shivambu et al. 2020; Marshall et al. 2022), suggesting they were likely smuggled to Australia to meet demands from the exotic pet trade. However, due to limited metadata in the interception record dataset, it is difficult to conclusively identify instances of deliberate introduction.

Recommendations

Australian biosecurity is not only a matter of national concern, but one of global importance. Non-native species introduced to Australia have the potential to become secondary sources for invasion in other countries. Strengthening efforts to prevent the entry and establishment of non-native invertebrates is crucial, not only for protecting Australia's agriculture, economy, ecosystems, and public health, but for contributing to global biosecurity. Effective biosecurity systems must support both prevention and rapid response, as many invasive invertebrates are only detected after they cross the border. Preventative strategies are consistently more effective and economically viable than reactive responses (Arthur et al. 2015; Hoffmann

and Broadhurst 2016). In this context, and with the information we were provided in the interception datasets, we present recommendations designed to enhance the resilience of Australia's biosecurity system and support future biosecurity research. These recommendations can also inform systems in other biodiversity-rich countries facing similar biosecurity challenges. These actions are not only necessary to advance biosecurity and conservation research but also offer long-term cost benefits for Australia and its key trading partners.

1. Standardisation of taxonomy and development of centralised databases

The use of a consistent taxonomic naming backbone across all biosecurity practices would minimise the need for manual entry of taxonomic names and thereby reduce the risk of errors, synonyms, and redundant naming practices. While a taxonomic backbone now exists within the Department of Agriculture, Forestry and Fisheries, synergising past data to this backbone and establishing a system that is integrated across all departments collecting biosecurity data, including human health sectors, would further enhance data consistency and coordination.

2. Consistently reporting sampling effort and negative detections

Assessing and improving the competency of the border biosecurity system is challenging without comprehensive records of the screening and identification methods used (Saccaggi et al. 2016). Therefore, where possible, we suggest that future research and practice consider: 1) sampling effort and strategy (e.g., the number of shipping containers inspected over a given period); and 2) negative inspection results (e.g., the number of arriving international flights or passengers where no invertebrates were detected). Incorporating this information into analysis would allow for a broader evaluation of Australia's biosecurity system and would help determine whether temporal and spatial trends in interceptions arise from differing levels of resourcing, or from other underlying processes.

3. Increased awareness of the trade and smuggling of invertebrates

The global trade of terrestrial invertebrates is rapidly expanding, raising increasing concern for both biosecurity and conservation (Lassaline et al. 2025). There is a critical distinction between an invertebrate accidentally transported with goods and those deliberately smuggled into Australia. However, we were unable to distinguish between hitchhikers and trafficked specimens from the current dataset. While both pose biosecurity risks, the intentional smuggling of an invertebrate is linked to criminal activity, often involves large monetary values, and reflects market demand for specific taxa. Furthermore, detection probability for deliberately smuggled invertebrates is likely lower than for accidental hitchhikers, as traffickers typically conceal specimens within packaging to evade inspection (Sampson and Appiah-Opoku 2024). Invertebrates may also be transported within other smuggled wildlife consignments, including live plants, further reducing the likelihood of detection. Going forward, biosecurity activities should consider the growing threat of intentionally smuggled invertebrates, with continued development of integration between interception data, wildlife trade records, and enforcement agencies.

4. Continued investment in taxonomic capacity, biosecurity training and interventions

A strong biosecurity system in Australia is more important now than ever, as other globally significant biosecurity programs face reductions in staffing and funding. This includes recently announced staffing cuts within the United States Department of Agriculture (USDA) (Chadde 2025), and a net loss of 131 biosecurity positions in New Zealand in 2024 (Wallace 2024). More broadly, while the global economic damage costs of invasive species are continuously rising, investment in their management has remained relatively static (Diagne et al. 2021). Because biosecurity is inherently globally connected, these patterns raise concerns about preparedness for invasive species. As international investment lessens, Australia must continue to strengthen its own system to protect its biodiversity and primary production industries.

Effective interceptions and surveillance relies on continued advancements in taxonomy, genetics, molecular ecology, species distribution modelling, and the study of introduction pathways (Saccaggi et al. 2016; Deliveyne et al. 2023). However, a major barrier to these advancements is the global lack of taxonomic capacity (i.e., the ‘taxonomic impediment’) (Engel et al. 2021). Many intercepted invertebrates cannot be confidently identified due to a lack of scientific information on invertebrate taxonomy, alongside limited specialist expertise and identification resources (Early et al. 2016; Saccaggi and Ueckermann 2024). Furthermore, in practice, expertise is typically concentrated on invertebrate groups of high economic or regulatory concern (e.g., Thripidae), often leaving other groups deprioritised and identified only to higher taxonomic levels (Department of Agriculture 2019; Department of Agriculture Environment and Water 2021).

Molecular tools such as DNA barcoding and environmental DNA (eDNA) detection, offer promising solutions for species identification and biosecurity surveillance (Mendoza and Francke 2017; Trujillo-González et al. 2022; Deliveyne et al. 2023). Yet, the effectiveness of these methods depends on the availability of comprehensive reference libraries and experienced people to interpret the results (Hopkins and Freckleton 2002; deWaard et al. 2010; Collins et al. 2013). Sustained investment is needed in cross-sector training programs (e.g., taxonomy and eDNA detection methods), molecular diagnostic infrastructure, and the development of digitised and accessible reference libraries. Complementary citizen science programs alongside investment by critical industries (e.g., mining and transport sectors) could further expand (post-border) invasive species surveillance, and with further support, improve the detection and rapid eradication of invasive invertebrates that bypass border surveillance (Ricciardi et al. 2017).

Conclusion

Our study provides the most comprehensive analysis to date of terrestrial invertebrate interceptions at the Australian border, revealing clear temporal, spatial and taxonomic patterns over a nine-year period. More than 2,400 species were recorded, and only 40.5% of interceptions were identified to species level. A small number of taxa accounted for a disproportionate number of interceptions, while new species continued to be detected throughout the study period. The presence of nationally significant pest species and popular exotic pets underscores the two-fold risks of biological invasions and wildlife trafficking. Although the number of

interceptions per species may not directly reflect their likelihood of establishment in Australia, continued research into other ecological and trade-related factors influencing establishment success remains essential. Moreover, the high economic cost of managing and eradicating invertebrates post-border highlights the importance of detecting and identifying organisms before they establish. Findings from this study can be used more broadly as a model system for international biosecurity research, from which conclusions on invertebrate transport and interception efforts can be drawn. They highlight the need for enhanced analytical capacity, targeted inspections and surveillance along high-risk pathways, and sustained investment in border biosecurity systems to mitigate future invertebrate incursions.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Use of AI

The following AI tools were used in the preparation of this manuscript (select all that apply):

Description: During the preparation of this work the authors used ChatGPT in order to run grammatical checks for several sentences. After using this tool/service, the authors generated, reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Interception time series

Authors: Charlotte R. Lassaline, Adam Toomes, Erinn P. Fagan-Jeffries, Phillip Cassey

Data type: docx

Explanation note: **figure S1.** A) Time series of daily invertebrate interception numbers between 2016 and 2024. B) Time series of daily invertebrate interception numbers split into individual years.

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Link: <https://doi.org/10.3897/neobiota.106.165823.suppl1>

Supplementary material 2

Data separation process for pathways

Authors: Charlotte R. Lassaline, Adam Toomes, Erinn P. Fagan-Jeffries, Phillip Cassey

Data type: docx

Explanation note: Details of the data separation process prior to observing correlations between introduction pathway explanatory and response variables.

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Link: <https://doi.org/10.3897/neobiota.106.165823.suppl2>

Supplementary material 3

Interceptions per Australian state

Authors: Charlotte R. Lassaline, Adam Toomes, Erinn P. Fagan-Jeffries, Phillip Cassey

Data type: docx

Explanation note: Number of interceptions per state, and number of unique species identified in each state.

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Link: <https://doi.org/10.3897/neobiota.106.165823.suppl3>

Supplementary material 4

Global regions of interception origin

Authors: Charlotte R. Lassaline, Adam Toomes, Erinn P. Fagan-Jeffries, Phillip Cassey

Data type: docx

Explanation note: International regions of origin for invertebrate interception records.

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Link: <https://doi.org/10.3897/neobiota.106.165823.suppl4>

Supplementary material 5

Intercepted priority pest species

Authors: Charlotte R. Lassaline, Adam Toomes, Erinn P. Fagan-Jeffries, Phillip Cassey

Data type: docx

Explanation note: Intercepted species listed under NPPPL and EPPL, and their total number of interception records.

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Link: <https://doi.org/10.3897/neobiota.106.165823.suppl5>